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FM 30–20

WAR DEPARTMENT

BASIC FIELD MANUAL

MILITARY INTELLIGENCE
MILITARY MAPS

RESTRICTED

BASIC FIELD MANUAL

MILITARY INTELLIGENCE

MILITARY MAPS

CHANGES No. 1

WAR DEPARTMENT,
WASHINGTON, *January 6, 1941.*

FM 30–20, May 27, 1940, is changed as follows:

2. SCOPE.

* * * * * * *

b. In addition to this manual, AR 300–15 and FM 30–21 cover the coordination of military mapping. Other publications of a general nature pertaining to maps and mapping are found in the Appendix.

[A. G. 062.11 (1–6–41).] (C 1, Jan. 6, 1941.)

3. MILITARY MAPPING DOCTRINES.

* * * * * * *

c. Detailed regulations covering maps and mapping are found in AR 300–15.

[A. G. 062.11 (1–6–41).] (C 1, Jan. 6, 1941.)

14. PRODUCTS FURNISHED.

* * * * * * *

b. Photography for general use.—(1) In a theater of operations, corps aviation will furnish aerial photographs, including stereo-pairs and triplets needed for intelligence purposes, in quantities prescribed in FM 30–21. When directed by proper authority, Air Corps units will furnish uncontrolled mosaics limited to ten prints. Limited quantities of prints required for other uses, including those needed for laying of mosaics, will also be furnished by the Air Corps. When directed by the proper commander, contact prints produced by the rapid contact printer or lithographic reproductions of aerial photographs will be reproduced in quantity and distributed by the Corps of Engineers. Copies of negatives normally will be supplied to the Corps of Engineers for this

quantity production. The Air Corps will store and file the originals of the aerial negatives of this type of photography.

* * * * * * *

[A. G. 062.11 (1–6–41).] (C 1, Jan. 6, 1941.)

■ 26. GENERAL ENGINEERING SPECIFICATIONS.—*a.* The production of maps and photomaps will be based on the general engineering specifications prescribed by the Chief of Engineers and as limited by the provisions of AR 300–15. These specifications will include regulation of the following:

* * * * * * *

[A. G. 062.11 (1–6–41).] (C 1, Jan. 6, 1941.)

■ 30. MAP CLASSIFICATION.

* * * * * * *

b. Types of maps.—Maps for use in a theater of operations naturally fall into classification according to scale. The use of the various types of maps will depend upon the character of the theater of operations, type of operations, and nature of the opposition encountered. Although listed below under various groups of scales for convenience and clarity, maps should normally be designated by their specific scales. Designation of maps by general terms descriptive of a range of scales or by purpose or use is not precise and is confusing.

* * * * * * *

(2) *Intermediate scale maps.*—Maps of intermediate scale, normally from 1:200,000 to 1:500,000, are intended for planning strategic operations, including the movement, concentration, and supply of troops. The Strategic Map of the United States, 1:500,000, has been designed for these purposes. Maps of a scale of about 1: 250,000 are particularly applicable to movements of armored forces and for maps of maneuver areas.

* * * * * * *

[A. G. 062.11 (1–6–41).] (C 1, Jan. 6, 1941.)

■ 36½. SIZE OF MAPS.—*a.* The size of map sheets issued in a theater of operations is limited primarily by the size of the lithographic presses of reproduction plants accompanying the various map-making echelons. Equipment for overprinting maps is influenced by size of maps available. Such sizes as

may be adopted from time to time are subject to change with invention and improvement of presses and technique. Definite sizes should be adopted based on the equipment on hand.

b. Maps used for training should conform to the sizes which have been adopted. The use of large sized maps which can be prepared on presses found only in rear area installations, or of extremely small sized, limited area maps which cannot be furnished in a rapidly moving situation, should be discouraged.

[A. G. 062.11 (1–6–41).] (C 1, Jan. 6, 1941.)

■ 38. RESPONSIBILITY.—*a.* In addition to duties relative to map supply and distribution, as prescribed in AR 300–15, the Chief of Engineers will, * * * the theater of operations.

* * * * * * *

[A. G. 062.11 (1–6–41).] (C 1, Jan. 6, 1941.)

■ 42. INITIAL ALLOWANCE OF MAPS.—*a.* Map allowances are based on the principle that each individual or organization should have an adequate supply of maps of areas in which they are currently operating, or in which they have an immediate prospective interest. Units should not be burdened with maps of areas outside their zone of operations, but should have adequate maps of regions of their present operations and of their immediate future operations. Difficulties of production and distribution, as well as the considerable weights involved, necessitate economy in map issues. Sectors assigned and operations contemplated are the bases for map distribution. The allowances prescribed herein are sufficient for minimum needs only; intervening organizations not specifically authorized to stock maps will not retain copies, but will distribute those received with the object in view of furnishing front-line units with maps needed by them for operations. Proper economy dictates that the only large-scale maps furnished shall be those of the areas of immediate importance to the individual or unit. The initial allowance of military maps will normally be as follows:

	Small scale: Normally 1:1,000,000 to 1:7,000,000	Intermediate scale: Normally 1:200,000 to 1:500,000 [1]	Medium scale: Normally 1:50,000 to 1:125,000	Large scale	Aeronautical charts
(1) *Headquarters:*					
GHQ	100	100	50	10	50
Army	25	75	50	10	25
Corps	15	40	75	10	25
Division	5	25	55	20	10
Regiment	1	7	7	14	0
Battalion [1]	0	3	6	6	0
Company	0	[2] 1	1	1	0
(2) *For individual use in organizations in addition to above allowance.* (On basis of commissioned strength.)	0	[2] 1	[3] 1	[4] 1	0
(3) *Air Corps:*					
GHQ	25	15	15	0	50
District headquarters and oversea air force	5	15	15	0	100
Wing headquarters	5	7	7	0	10
Group headquarters	5	7	7	0	10
Squadron headquarters	1	7	7	0	4
Airplane	0	0	1	[5] 1	4

[1] Allowance for separate battalions, Cavalry, Armored Force, and motorized Infantry will be increased 50 percent.

[2] For Cavalry, Armored Force, motorized Infantry, and attached troops only.

[3] Except for officers of Air Corps. (Allowances for artillery observation missions prescribed in note (5) below.)

[4] Except Air Corps, see note (5) below. (Use by Cavalry and Armored Force will be exceptional.)

[5] Observation squadrons only. Airplanes observing artillery fire will be issued same scale maps used by artillery firing batteries.

b. (1) If maps of any of the scale groupings in *a* above are not available, substitution is authorized of maps of the scale nearest to that desired, and in quantities provided above for the map replaced.

(2) Special maps and road maps will be issued as directed by the commanding officer.

[A. G. 062.11 (1–6–41). (C 1, Jan. 6, 1941.)

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:

E. S. ADAMS,
Major General,
The Adjutant General.

U. S. GOVERNMENT PRINTING OFFICE: 1941

RESTRICTED

FM 30–20

BASIC FIELD MANUAL

MILITARY INTELLIGENCE

MILITARY MAPS

Prepared under direction of the
Chief of Staff

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON: 1940

WAR DEPARTMENT,
WASHINGTON, *May 27, 1940.*

FM 30–20, Military Intelligence, Military Maps, is published for the information and guidance of all concerned.

[A. G. 062.11 (4–9–40).]

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:

E. S. ADAMS,
Major General,
The Adjutant General.

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BASIC FIELD MANUAL

MILITARY INTELLIGENCE

MILITARY MAPS

SECTION I

GENERAL

■ 1. PURPOSE.—This manual is intended to supply to the intelligence division of general staffs the information needed for coordination of the Engineer-Air Corps mapping team and for coordination of the engineer and artillery survey detachments. It is also intended to supply information of a general nature regarding maps needed by staff officers of all units.

■ 2. SCOPE.—*a.* This manual sets forth the fundamental considerations relative to map production, reproduction, and issue. It indicates the coordination required between the mapping agencies and the coordination required between survey troops, including those of the artillery. It gives map information of a general nature, including the types of maps likely to be available, their allowance, supply, and distribution. The map needs of the using arms are indicated. Technical methods and details pertaining to map production and reproduction are not covered herein, but are prescribed in the Field Manuals and Technical Manuals of the arms concerned. Information of an elementary nature, such as map and aerial photograph reading, is covered in appropriate Field Manuals.

b. In addition to this manual, AR 100–15 and FM 30–21 cover the coordination of military mapping. Other publications of a general nature pertaining to maps and mapping are found in the Appendix.

■ 3. MILITARY MAPPING DOCTRINES.—*a.* The availability of suitable maps will greatly facilitate coordination of the use of troops, as well as the efficiency of the troops themselves. The vast extent of unmapped areas which may exist in the theater of operations necessitates that provisions be made for mapping as operations progress.

b. The production, reproduction, and supply of military maps will be governed by the following doctrines:

(1) The field forces must be prepared to map as they move.

(2) Sufficient personnel must be trained and ample equipment must be available to start mapping at, or even in advance of, the beginning of operations.

(3) The mapping agencies, Air Corps and Corps of Engineers, will devote their peacetime mapping activities to training and preparation for wartime mapping by projection of control by photogrammetry (par. 6*g*).

(4) Appropriate echelons of the Air Corps will be organized, equipped, and trained in time of peace to meet both the requirements of the engineer topographic troops for mapping photography and also the needs of the troops for single lens photographs, overlapping pairs, small mosaics, composites, and obliques.

(5) Commanding officers of appropriate echelons are responsible for—

(*a*) Coordination of mapping activities of those agencies in the Army responsible for mapping, the Air Corps and the Corps of Engineers.

(*b*) Map supply.

(6) The supply of aerial photographs and maps requires continuous coordination and supervision, both as to procurement and distribution. Means must be provided in appropriate echelons for making maps, procuring photographs, and reproducing both in quantity.

(7) Where suitable maps for military purposes do not exist, the aerial photograph in its various forms must be accepted as a map. It must serve not only as a map, but as a means of producing a map. Where suitable maps are available, the aerial photograph is used to supplement the information on the maps.

(8) The reproduction of aerial photographs in quantity, large mosaics, and photomaps, and the production with minimum delay by photogrammetric methods of maps of a type to meet the needs of the combat troops are responsibilities of the Corps of Engineers.

(9) Map and photographic reproduction equipment will be sturdy and as mobile as possible.

(10) Reproduction of maps and photographs in quantity will be decentralized.

c. Detailed regulations covering maps and mapping are found in AR 100–15.

■ 4. RESPONSIBILITY.—*a.* In large units, the assistant chief of staff, G–2, acting under the authority of the commander thereof, will prepare plans and policies and supervise all activities concerning military topographic surveys and maps, including their acquisition, reproduction, and distribution.

b. The Corps of Engineers and the Air Corps are jointly charged with the preparation of maps requiring the use of aerial photographs.

(1) The Corps of Engineers is charged with the prosecution of surveys, the photogrammetric processes or compilations for the production or revision of maps required for military purposes, and with map reproduction, supply, and distribution.

(2) The Air Corps is charged with aerial photographic work for military mapping operations in accordance with specifications prepared by the Corps of Engineers, and for photography to meet the intelligence needs of combat troops.

■ 5. THE MAP AS AN INTELLIGENCE DOCUMENT.—*a. Conventional maps.*—A military map is the result of a terrain reconnaissance and is the graphic report of the reconnaissance. It is a military intelligence terrain study presented by means of symbols. The map is as much an intelligence document as the report of a military observer and is subject to inaccuracies similar to those found in a written or oral report. These inaccuracies may result from a lack of complete reconnaissance, unfavorable weather conditions, unsatisfactory equipment, or lack of training of personnel.

b. Aerial photographs.—The aerial photograph when used as a map is also an intelligence document. Due to physical limitations, only a small area can be covered by each aerial photograph and information on the photograph is normally shown in great detail. The cartographer can analyze and condense photographic information in accordance with the type of map desired in a manner similar to that used in the preparation of intelligence digests

■ 6. GLOSSARY.—*a. Battle map.*—A map, prepared normally by photogrammetric means and at a scale of 1:20,000, which is suitable for the tactical and technical needs of all arms.

b. Composite.—A photomap prepared from exposures made simultaneously with a multiple-lens camera. When carefully laid by the use of appropriate trimmers and templates, it may be considered as the equivalent of a photograph made with a wide angle lens camera.

c. Map.—A map is defined as a plane representation of a portion of the earth's surface by means of conventional signs.

d. Map substitute.—A generic term used to designate the substitute map that can be produced in a matter of hours. The map substitute may consist of direct reproductions of wide coverage aerial photographs, photomaps or mosaics, or of provisional maps.

e. Mosaic.—A mosaic is an assembly of two or more overlapping vertical photographs. Inherent errors of component pictures persist. Mosaics prepared from single lens type of camera can be projected only a few miles into enemy territory and cover only a limited area when prepared without geodetic control. When issued with a planimetric map of the area, the value of both will be greatly enhanced.

(1) *Controlled mosaic.*—Fitted to a control plot, with rephotographing of certain component verticals in order to compensate for scale variations resulting from tilt, and from variations in flight altitude. The preparation is a time-consuming procedure. Controlled mosaics are prepared by the Corps of Engineers.

(2) *Strip mosaic (reconnaissance strip).*—Compiled by assembling one strip of verticals taken on a single flight. Available control may be used, or a partial control effected by matching center points on adjacent pictures.

(3) *Uncontrolled mosaic.*—An assembly of two or more overlapping vertical photographs when assembled only by the matching of photographic detail, without the benefit of a framework of control points. It can be produced rapidly.

f. Oblique.—A single aerial photograph taken with the camera pointed obliquely downward.

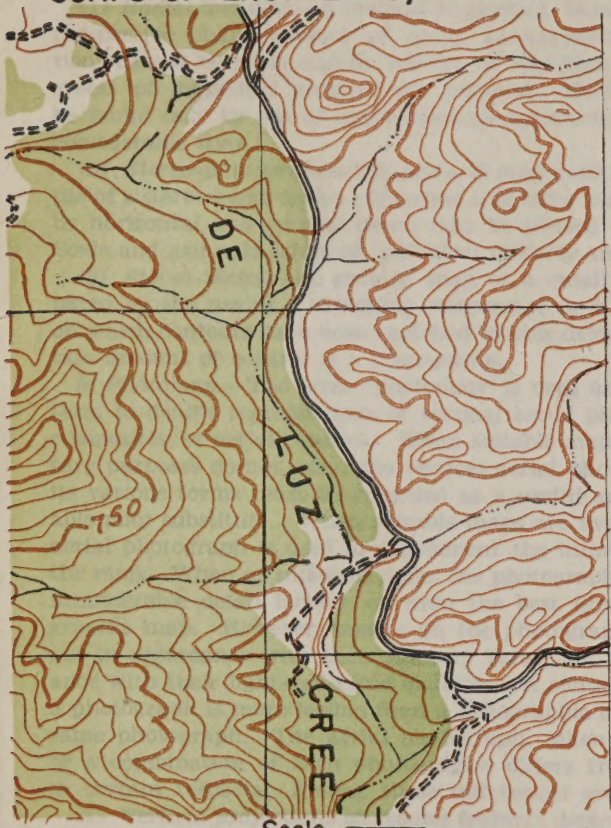
(1) *High oblique.*—Shows the horizon.

(2) *Low oblique.*—All of the picture is below the horizon.

BATTLE MAP

WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY



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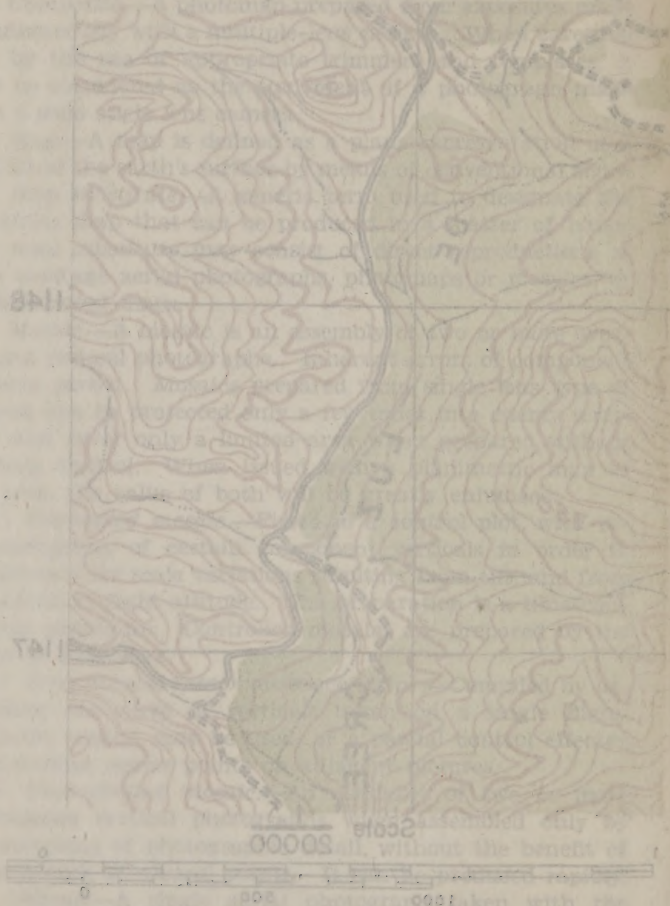
Contour interval 50 feet

Datum is mean sea level

CALIFORNIA

SAN DIEGO CO

228460—40 (Face p. 4)


1148
1147
Scale
20000
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g. Photogrammetry.—The science of preparing graphic maps from aerial photographs. Control is a prerequisite. Maps may be prepared by various methods, as follows:

(1) *Radial line plot.*—A method of plotting, based upon the perspective characteristics of aerial photographs. Distortions caused by relief and by the tilt (if less than a few degrees) of individual pictures are removed. Elevations can be found only by use of supplementary apparatus requiring considerable time.

(2) *Stereo-photogrammetric plot.*—A map produced by the use of a stereoscopic device employing a floating mark, whereby horizontal and vertical detail may be plotted accurately. Scale and azimuth errors of individual pictures are canceled.

(3) *Stereo-sketch.*—A graphic map of a small area prepared by the use of a sketching stereoscope or a photomap on which contours have been sketched by this device. A certain amount of control is a prerequisite.

h. Photomap.—The term "photomap" is used as a general term to denote reproductions of vertical aerial photographs, composites, or aerial mosaics. When suitable maps for military purposes do not exist, the vertical aerial photograph in its various forms must be regarded as a useful and acceptable map substitute. When suitable maps are available, the aerial photograph is used to supplement the information on the map. When at sufficient scale, the photograph furnishes innumerable detail lacking on even the best type of topographic map. However, images on the photographs appear not in accordance with their military value, but in accordance with their light-reflecting qualities. A contact print of a photograph is more legible than a lithographic copy of the same photograph. The aerial photograph, taken vertically, or a combination of such photographs, differs from a map in certain respects. Among these differences are—

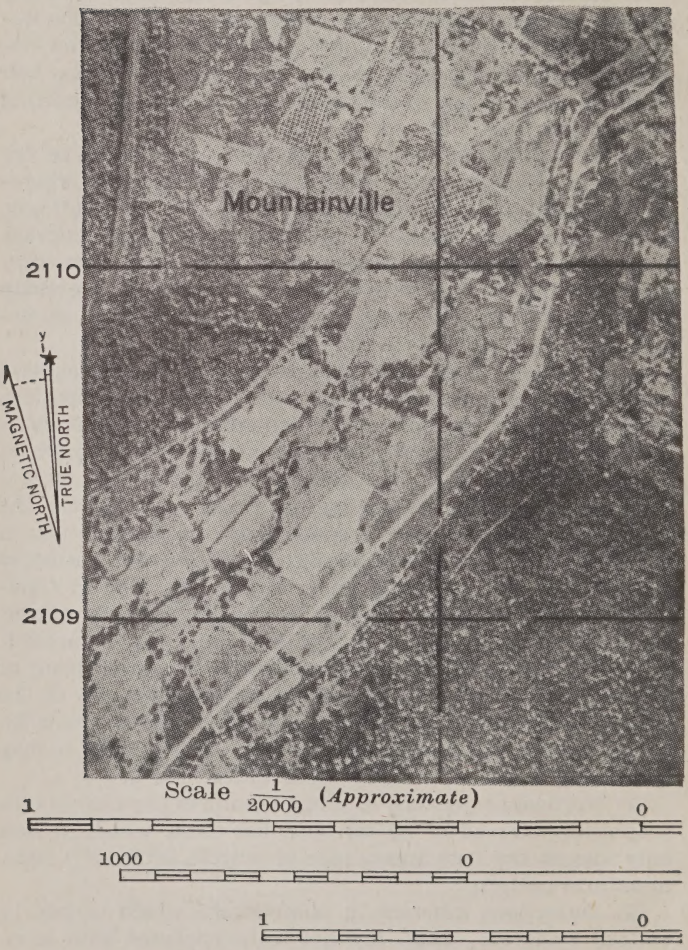
(1) Vertical projections of ground features depicted photographically instead of by conventional signs, which at best only suggest the true appearance of objects, often in a rigid, unnatural pattern.

(2) Distortions inherent in photographs which cannot be entirely removed. These are not to be confused with inaccuracies in a map caused by faulty preparation.

PHOTO MAP

WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY



WEST POINT AND VICINITY

FIGURE 2.—Photomap.

i. Pinpoints.—When two or more aerial photographs are taken of an isolated area or spot the result is called a "pinpoint." These are normally taken for intelligence purposes. A minimum of two photographs is taken in order to provide for stereo-examination. They are frequently made of enemy airdromes, supply depots, dumps, bridges, road crossings, etc., behind the enemy's lines, and of other features which require more detailed study than is afforded by the smaller scale photograph.

j. Provisional map.—A provisional map is produced by compiling existing map detail or by tracing data from aerial photographs. It may contain form lines or contours. If prepared from aerial photographs, it will include the errors of horizontal scale existing in the photograph.

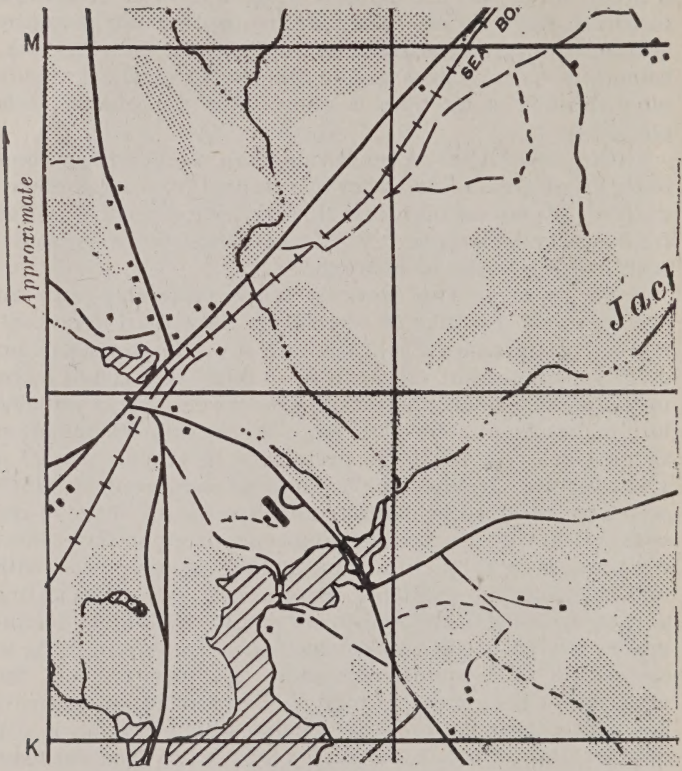
k. Stereo-pair.—Two verticals taken preferably with an overlap of not less than 60 percent nor more than 75 percent. Stereoscopic examination of the area of overlap reveals minor details of the terrain, especially as to relief, not seen at all by inspection of a single photograph, thereby furnishing valuable information to military observers. Stereoscopic examination should always be sought in preference to examination of a single vertical. An anaglyph is a form of stereogram on which a picture is formed by almost superimposing an image in red over one in blue to secure stereoscopic or perspective effect when observed through an anaglyphoscope—spectacles with one blue and one red lens. Several methods of indicating perspective relief of the terrain are in use. With aerial photographs available, the simplest method is the overprinting in two colors of a stereoscopic pair. Another method, the anaglyph of the contoured map, is the result of an expensive and time-consuming process. The polaroid anaglyph is still another form of portraying three dimensions. The anaglyph is used to give better and more detailed appreciation of the terrain, to give three-dimensional vision, and to aid in stereoscopic instruction.

l. Stereo-triplet.—Three verticals such that the entire area of the center picture is overlapped by the other two. In campaign, stereo-pairs and triplets will normally be furnished

WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY

PROVISIONAL MAP



Approximate Scale 1: 20,000

0 MILES

1000 0 YARDS

Camp Jackson and vicinity

in 6 sheets, Sheet No. 4

FIGURE 3.—Provisional map.

without cutting, trimming, or mounting. (See FM 30–21 for methods of tilting, marking, and identification.)

m. Vertical.—An aerial photograph taken with the axis of the camera as vertical as possible. It has inherent, but relatively small, errors of scale and azimuth resulting from tilt, variations in relief, and optical distortions.

n. Wide-angle photograph.—An aerial photograph taken with a camera which has a cone angle of approximately 90°.

SECTION II

ENGINEER MAPPING TROOPS

■ 7. CHANNEL OF COMMAND.—Topographic battalions and companies will normally work directly under the technical supervision of the engineer of the command to which they are assigned.

■ 8. DUTIES OF COMMANDERS OF TOPOGRAPHIC ORGANIZATIONS.—Commanding officers of topographic troops assigned to the various echelons are charged with the following duties:

a. Direct command of unit and technical direction, control and coordination of all geodetic, topographic, and photogrammetric surveys carried out by his organization.

b. Supervision of the receipt and filing of all topographic data received from higher, lower, and adjacent echelons.

c. Maintenance of liaison with topographic units of adjacent, higher, and lower echelons.

d. When called upon, to furnish technical advice on topographic matters.

e. Supervision of the storage of maps, aerial photographs, and negatives and of such other photographs or negatives as may be turned over to him.

f. Examination and utilization of captured maps furnished by military intelligence sections.

g. Supervision of the production and issue of records of geodetic positions for use by higher, lower, and adjacent topographic units and by artillery survey units.

■ 9. TOPOGRAPHIC TROOPS AVAILABLE IN VARIOUS ECHELONS.—The topographic troops available in the various echelons of command are as follows:

Topographic unit	Where found	Remarks
Engineer battalion, topographic, GHQ.	Each major theater of operations.	1 battalion only.
Engineer battalion, topographic, army.	Each army	1 battalion normally employed on army mission.
Engineer company, topographic, corps.	Each corps	1 company to provide prompt map information needed by the corps.
	Each division	No topographic or reproduction troops assigned.

■ 10. FUNCTIONS AND CAPABILITIES OF TOPOGRAPHIC TROOPS.—*a. Topographic battalion, GHQ.*—The preparation of large quantities of maps, particularly those of permanent utility, will ordinarily be a function of the GHQ topographic battalion. This battalion will also be able to reproduce any special sketches and drawings which may be required. In addition to its map reproduction function, it is organized and equipped to produce maps by photogrammetric methods and to produce the various types of provisional and photomaps. Lithographic reproduction is performed under conditions approaching those of a permanent peacetime establishment.

b. Topographic battalion, army.—The army topographic battalion's primary mission is to produce by photogrammetry, battle maps of unmapped areas for tactical and fire-control use. It is equipped to provide maps to a depth of about 30 miles into hostile terrain. The first sheets should appear about 2 weeks after receipt of aerial photographs; subsequent sheets should be published at a rate of about 100 square miles per day. The objective is to provide maps adequate and suitable for the use of all arms and of sufficient accuracy for artillery fire control. In an unmapped theater of operations, time available will seldom allow the battalion to provide maps covering the entire army front. However, because of the long period required by the army for planning an operation, the

battalion should be able to meet the minimum map needs of the army for accurate maps. The battalion is also organized for quantity reproduction to meet the more local reproduction needs of the army, including such sketches and drawings as may be required. Maps prepared by the army topographic battalion are reproduced under conditions approaching those of a permanent establishment, but often with greater time restrictions than in the case of GHQ reproductions.

c. Topographic company, corps.—The corps topographic companies are equipped to prepare and reproduce provisional and photomaps, mosaics, maps of limited areas, overprints, overlays, and sketches, and to reproduce existing maps. They provide rapid information needed by corps units, as contrasted with the more accurate information at greater depths provided by the army. Map substitutes from aerial photographs can be provided within 12 to 24 hours from the time the photographs are delivered to the topographic companies. The companies are equipped with rugged, portable presses which operate under field conditions. The survey sections of the corps topographic companies will also be able to extend to a limited degree the horizontal control needed for the coordination of artillery fire. Photography for the corps topographic companies will normally be performed with the wide-angle camera by corps aviation.

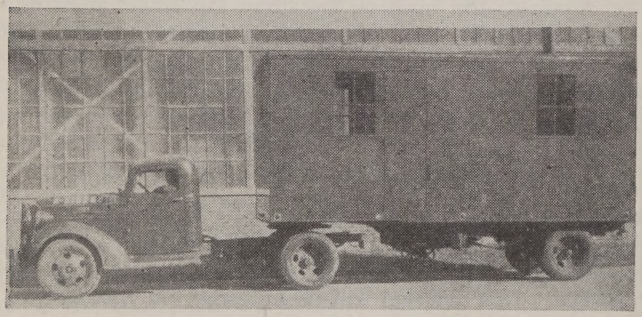


FIGURE 4.—Mobile map reproduction plant (corps topographic company).

d. Division engineers.—No topographic unit or detachment will be provided for infantry divisions. When operating independently, a division may be reinforced with detachments from the topographic company of the corps.

■ 11. Coordination With Artillery Survey Troops.—*a.* It is the responsibility of the chief engineer in the theater of operations to furnish to the artillery through the engineers of subordinate echelons, appropriate data concerning monuments, bench marks, and other control points in the artillery zone of action in form for use by artillery survey personnel.

b. Insofar as is consistent with their mapping mission, engineer topographic troops will render all assistance possible to artillery survey personnel. Corps and army commanders will take the necessary measures to insure coordination of the work of all artillery survey detachments under their command. Artillery survey detachments will make maximum use of the survey control data secured incident to the preparation of maps, so that the survey work of the different artillery units will be tied together on the same framework as the maps, existing or projected, to the end that all artillery within range may be brought to bear on designated targets without delay.

c. Joint training between artillery survey personnel and topographic engineers, particularly those of corps companies, will be conducted whenever possible.

d. Much of the work of the surveying detachment of the corps topographic company will be the breaking down of the main control, carrying it forward, and increasing the density so that it will be available for the artillery in any location.

Section III

AIR CORPS PHOTOGRAPHIC TROOPS

■ 12. Air Corps Photographic Troops Available in Various Echelons.—*a. GHQ and army.*—Reconnaissance aviation is assigned for GHQ and army reconnaissance and mapping missions. This aviation will be equipped for photography as follows:

(1) Reconnaissance aviation with GHQ is of the bombardment type. It is equipped for various types of photography incident to its reconnaissance missions, but normally will

not be provided with the special equipment nor be called upon to do the specialized photography for photogrammetry.

(2) Army reconnaissance aviation is of the light bombardment type and is equipped for photography to a greater extent than the reconnaissance squadrons within GHQ aviation. Reconnaissance squadrons are organized for the mapping photography needed by the topographic battalions. Due to the weight of mapping cameras and the large crew needed, airplanes of the light bombardment type equipped for high-altitude flying are indicated. Personnel should be especially trained in the precision photography required for photogrammetric mapping.

b. Corps.—The aviation assigned to each corps is equipped with two different types of airplanes; one type suitable for corps and division reconnaissance and the other for short-range observation and liaison missions. Reconnaissance type aviation with the corps is organized and equipped to furnish the wide-angle mapping photographs which may be required by the corps topographic company for the preparation of map substitutes. These wide coverage photographs may be furnished by higher echelons in more or less stabilized situations, but in mobile situations the corps must be prepared to provide its own mapping photography of the immediate area in which it is operating. Photography, both for intelligence and reconnaissance, is also performed by corps aviation, generally with smaller coverage cameras at lower altitudes.

■ 13. EMPLOYMENT OF AIR CORPS MAPPING ECHELONS.—*a. Reconnaissance squadrons.*—(1) The Air Corps will provide the personnel, aircraft, cameras, and other necessary equipment to meet the requirements for aerial photographic work of the engineer topographic battalions. The commanders of squadrons on photographic mapping missions will be responsible for the exposure and processing of photographic negatives and prints according to specifications and priorities set up by the engineer charged with mapping operations. The photography required by the topographic battalions will be of the multiple-lens or wide-angle single-lens type.

(2) In war, aerial photography for mapping purposes must be continuous, beginning upon or in advance of military operations. Not only must the immediate area of operations be photographed, but the other critical or probable areas of contact should be covered as early as practicable. The availability of mapping information in war, particularly in mobile situations, will require careful planning and continuous photography during all periods of favorable atmospheric conditions. Adverse weather conditions may cause long and frequent periods of unsuitable visibility for photographic purposes and extreme sensitivity of mapping aviation to enemy activity makes military mapping photography a matter of opportunity. Air Corps mapping units must not be diverted to other missions but when grounded due to weather must be held in readiness to perform map photography at the first opportunity. Mapping aviation must be provided with adequate protection when necessary.

(3) The exacting requirements of aerial mapping photography necessitate skilled mapping pilots and camera technicians as well as specially designed equipment. Efficient personnel must be trained and ample equipment must be available to start systematic photography at the outbreak of hostilities.

b. Corps aviation.—The mapping functions of corps aviation will consist in securing the wide coverage small scale aerial photographs required by the corps topographic companies and the large scale photographs needed for intelligence or combat purposes.

■ 14. PRODUCTS FURNISHED.—*a. Photography for mapping.*—Air Corps units charged with mapping photography are responsible for making negatives, marking them for ready identification, making such prints as may be required, and for indexing and filing the negatives.

b. Photography for general use.—(1) In a theater of operations, corps aviation will furnish aerial photographs, including stereo-pairs and triplets needed for intelligence purposes, in quantities prescribed in FM 30–21. Limited quantities of prints required for other uses, including those needed for lay-

ing of mosaics, will also be furnished by the Air Corps. When directed by the proper commander, contact prints produced by the rapid contact printer or lithographic reproductions of aerial photographs will be reproduced in quantity and distributed by the Corps of Engineers. Copies of negatives normally will be supplied to the Corps of Engineers for this quantity production. The Air Corps will store and file the originals of the aerial negatives of this type of photography.

(2) The wide coverage small scale aerial photography required by the corps topographic companies, and aerial photography incident to the preparation of single photographs, vertical and oblique, stereo-pairs and triplets, night photography, and rapid production photography in which negatives are processed in whole or in part in the airplane, are functions of photographic sections of corps aviation. Such units can make photographs for compilation into mosaics. Their means permit the production of but limited quantities of contact prints and the laying of small mosaics of less than ten prints. Laying of mosaics of a large number of prints or quantity reproduction of mosaics will be the responsibility of engineer troops. Observation aviation normally will not be equipped for printing and mounting the product of the multiple-lens camera.

(3) Photographs taken for intelligence purposes may be useful in mapping, primarily in revision, and their use may obviate the necessity for sending special mapping photographic missions over enemy territory.

■ 15. MAPPING PHOTOGRAPHY.--Mapping photography is performed at high altitudes with wide coverage cameras to permit photographing of extensive areas in a minimum length of time and with the least number of pictures, at a scale consistent with a proper delineation of the terrain. Such photography is ordinarily not suitable for intelligence purposes because of the small scale and lack of detail. However, mapping photography, even though of small scale and especially when taken over enemy terrain, may contain important information, and prints of all mapping photography should be made available to military intelligence officers for study.

■ 16. INTELLIGENCE PHOTOGRAPHY.—Aerial photography is an important source of military information. Normally it is secured by reconnaissance or by corps and division aviation especially assigned on intelligence missions and taken at low altitudes in order that the ground may be studied in greater detail. Intelligence photographs must be utilized to the maximum by all appropriate echelons in securing, checking, and disseminating information. Intelligence photography may be classified as spot photography as contrasted with area photography for mapping purposes. Photography for intelligence purposes should not be confused with mapping photography.

■ 17. TITLING OF AERIAL PHOTOGRAPHS.—Titling of aerial photographs will be done by the Air Corps as prescribed in FM 30–21.

■ 18. COORDINATION OF REQUESTS FOR PHOTOGRAPHY.—The commanding officers of organizations to which Air Corps units are attached or assigned will, through their assistant chiefs of staff, G–2, coordinate requests for photography emanating from the Corps of Engineers and others.

SECTION IV

TRAINING OF ENGINEER-AIR CORPS MAPPING TEAM

■ 19. METHODS.—*a.* Engineer topographic troops and Air Corps photographic squadrons will jointly participate in mapping activities for training in the use of wartime methods for perfection of the teamwork required in the proper performance of their wartime mapping missions.

b. When practicable, and in the course of their training, designated engineer officers will be given instruction in all operations incident to mapping photography, except pilotage, and Air Corps officers in ground control and photogrammetry, so that members of the mapping team will understand the capabilities and limitations of each arm. The duties of junior engineer officers and of senior noncommissioned officers assigned to topographic battalions will be so arranged that upon completing a tour, officers will have had experience in establishing ground control and in photogrammetry, and senior

noncommissioned officers will be familiar with both classes of work.

■ 20. MILITARY MAPPING MISSION.—*a. General.*—The lack of suitable topographic maps in the United States, as well as in many other possible theaters of operation, dictates that the mission of the Army mapping team, the Corps of Engineers and the Air Corps, must be prepared to provide rapidly suitable military maps under all conditions. The Army must be prepared to map as it moves. This requires decentralization of map preparation and supply. Time is a vital factor in war, but the accuracy of the type of map furnished must necessarily be a function of the time available for its preparation.

b. Training.—Training of the Engineer-Air Corps mapping echelons for the performance of their various wartime mapping missions will be in unmapped areas. As an incident to such training, maps will be produced in certain strategic areas designated by the War Department. Work for these maps will be at scales suitable for the ultimate production of the battle map. They will, however, be published at a scale of 1:62,500, and will conform to the standard 15-minute U. S. Geological Survey quadrangles, with wooded areas and road classifications added. Field sheets for this mapping will be filed at corps area headquarters.

■ 21. DEVELOPMENT OF MAPPING METHODS.—The development of aerial mapping methods in recent years has revolutionized the art of military mapping. Maps which formerly required months to prepare by ground methods can now be produced in a period of days. Maps of unoccupied or hostile terrain can be produced by photogrammetrical processes. The possibility of the adoption of new scientific developments in the science of photogrammetry must be under constant study by members of the Engineer-Air Corps mapping team. In addition, the Air Corps and the Corps of Engineers will conduct experimental work for the development of improved photographic and photogrammetric equipment and methods. Existing military laboratories and units engaged in mapping will be utilized in this development. By suitable combined map-

ping exercises, methods and products of the mapping team will be tested to assure that mapping procedure is sound and the resulting product meets the need of the combat.

■ 22. MANEUVERS.—The various mapping echelons of the Corps of Engineers and of the Air Corps will participate whenever practicable in maneuvers of the combined arms in which they will be required to produce maps under wartime conditions, and to provide the various types of wartime maps for use during the maneuvers.

SECTION V

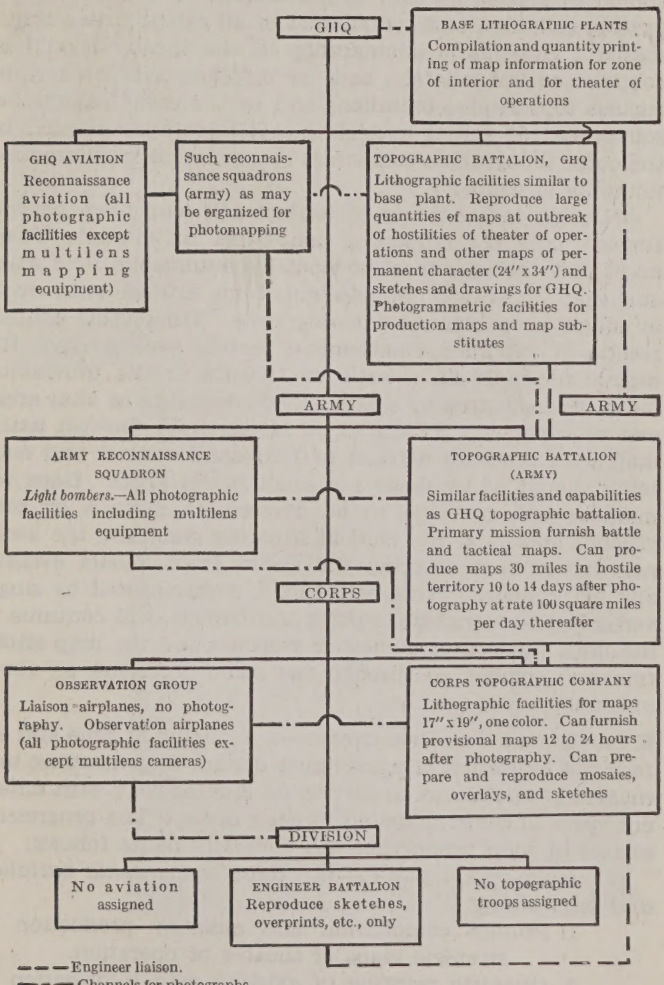
MAP PRODUCTION

■ 23. STATUS OF MAPPING.—Throughout the world, the status of military mapping varies from the complete coverage at all common military map scales, such as may be found for portions of Europe, to an entire absence of map information such as obtains in portions of South America. For the United States, only about 25 percent of its area is covered by maps of a scale of 1:62,500 or larger, and less than 10 percent by modern maps of a scale suitable for military use. Due to these facts, the strength, composition, and organization of topographic troops assigned to field forces are based on the assumption that the theater of operations will be in a relatively unmapped area. The small percentage of the United States which has been mapped has materially influenced the doctrines set forth in paragraph 3.

■ 24. GENERAL SCHEME.—*a.* Military mapping and reproduction operations in any campaign will depend upon the amount of satisfactory topographic information available at the outbreak of hostilities. However, no matter how complete the map coverage, revision and correction must be carried on constantly. Early mobilization and early concentration of mapping troops are essential so that no delay will be entailed in map production. Advance planning by all commanders is essential if the mapping situation is to keep ahead of the tactical situation.

b. At or prior to the outbreak of hostilities, general maps, as well as aeronautical charts and other special purpose maps

ENGINEER-AIR CORPS COORDINATION IN THE THEATER OF OPERATIONS


GHQ
BASE LITHOGRAPHIC PLANTS
Compilation and quantity printing of map information for zone of interior and for theater of operations
GHQ AVIATION
Reconnaissance aviation (all photographic facilities except multilens mapping equipment)
Such reconnaissance squadrons (army) as may be organized for photomapping
TOPOGRAPHIC BATTALION, GHQ
Lithographic facilities similar to base plant. Reproduce large quantities of maps at outbreak of hostilities of theater of operations and other maps of permanent character (24" x 34") and sketches and drawings for GHQ. Photogrammetric facilities for production maps and map substitutes
ARMY
ARMY
ARMY RECONNAISSANCE SQUADRON
Light bombers.—All photographic facilities including multilens equipment
TOPOGRAPHIC BATTALION (ARMY)
Similar facilities and capabilities as GHQ topographic battalion. Primary mission furnish battle and tactical maps. Can produce maps 30 miles in hostile territory 10 to 14 days after photography at rate 100 square miles per day thereafter
CORPS
OBSERVATION GROUP
Liaison airplanes, no photography. Observation airplanes (all photographic facilities except multilens cameras)
CORPS TOPOGRAPHIC COMPANY
Lithographic facilities for maps 17" x 19", one color. Can furnish provisional maps 12 to 24 hours after photography. Can prepare and reproduce mosaics, overlays, and sketches
DIVISION
No aviation assigned
ENGINEER BATTALION
Reproduce sketches, overprints, etc., only
No topographic troops assigned
Engineer liaison.
Channels for photographs.

must be secured and printed. Prompt compilation and quantity production of strategic maps of the probable theater should be started as soon as practicable, as well as the collection, collation, and compilation of all existing map information. Systematic photography of the theater should be commenced immediately, both by mapping aviation for the various topographic battalions and by the corps observation squadrons for initial and close-in photography needed by the corps topographic companies to supply quick information for units in contact.

c. During initial stages of contact and maneuver incident thereto, only the crudest of maps can be assured. These maps may take the form of available automobile road maps and map substitutes, supplemented for critical local areas by single or overlapping photographs. Where this contact results in extended engagements lasting several days, the mosaic normally on a scale of 1:20,000 or the provisional maps supplemented by single lens photographs of vital areas can be supplied. Within 10 or 14 days, the finished battle map with accurate vertical or horizontal control and contours should be available for small initial areas. Gaps remaining will continue to be covered by mosaics or provisional maps. If the tactical situation stabilizes, the accurate battle map covering the entire front should eventually be produced. This battle map, supplemented by single verticals and stereoscopic pairs and triplets, will continue in use until warfare of maneuver reoccurs and the map situation and combat go through the same procedure as above indicated.

■ 25. SEQUENCE OF OPERATIONS.—*a.* Economy of time and effort and limitation of opportunity dictate that mapping in a theater of operations be carried on progressively with different types of maps prepared in each phase. The progressive phases of map production will generally be as follows:

(1) *Mobilization phase.*—(*a*) *GHQ topographic battalion and base plants.*

1. Prompt compilation and quantity production of strategic maps of theater of operation.
2. Quantity printing of existing map information of probable battle areas.

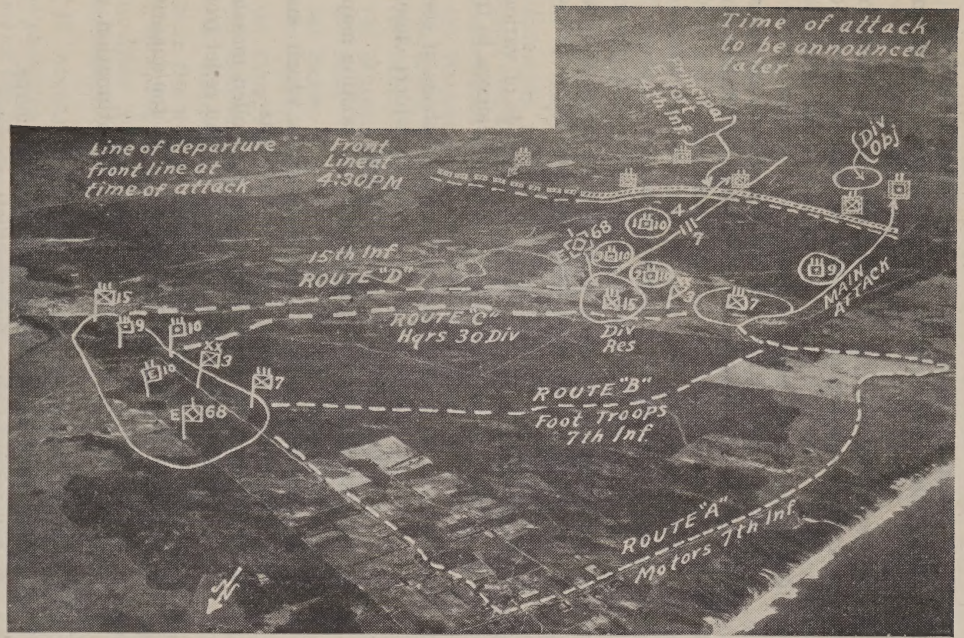


FIGURE 5.—Oblique photograph used as map substitute to accompany oral field order.

3. Preparation and printing of maps of concentration and training areas and strategically important frontier areas.

(*b*) *Army and corps units.*—Expansion, mobilization, and training.

(2) *Concentration phase.*—(*a*) *Base plants.*—Continuation of quantity printing for theater of operations and zone of interior.

(*b*) *GHQ topographic battalion.*

1. Reproduction of existing maps of theater of operations and preparation of strategical, tactical, and battle maps from existing data.
2. Establishment of control.
3. Assistance to army topographic battalions.

(*c*) *Army topographic battalions.*

1. Delineation of areas for systematic aerial photography of the unmapped areas and production of various forms of map substitutes.
2. Furnishing copies of prints or negatives of various forms of the product of the aerial camera to the corps for local reproduction.
3. Preparation by photogrammetrical methods of contoured battle maps of areas in which closely coordinated action is anticipated.
4. Map compilation and reproduction of existing maps.

(*d*) *Corps topographic companies.*

1. Reproduction of any map substitutes which may have been turned over by army units.
2. Preparation of uncontrolled and controlled mosaics and provisional maps with or without relief from products of corps photography.
3. Reproduction of existing tactical maps for quantity demand.

(3) *Combat phases.*—(*a*) *Base plants.*—Continuation of quantity printing.

(*b*) *GHQ topographic battalion.*

1. Continuation of production of existing maps.
2. Assistance to army topographic battalions.
3. Extension of control by ground methods in occupied territory.

4. Revision and correction of maps.
5. Preparation for future operations.

(c) *Army topographic battalions.*

1. Continuation of photography for future operations.
2. Extension of maps into enemy terrain.
3. Assistance to corps units.

(d) *Corps companies.*—Continuation of work on maps and map substitutes in areas not covered by battle maps.

b. The sequence of operations as given above is largely dependent upon receiving aerial photographs when needed. Adverse weather conditions or enemy antiair activities may delay aerial mapping work to a material extent. Military necessity dictates prompt mapping photography in a theater of operations and the need for advance planning for aerial photography to be required of the Air Corps.

■ 26. GENERAL ENGINEERING SPECIFICATIONS.—*a.* The production of maps and photomaps will be based on the general engineering specifications prescribed by the Chief of Engineers and as limited by the provisions of AR 100–15. These specifications will include regulation of the following:

(1) Projections.
(2) Grids, military and atlas.
(3) Map index.
(4) Marginal data.
(5) Size.
(6) Scale.
(7) Contour interval.
(8) Control.
(9) Conventional signs.
(10) Accuracy.

b. In the theater of operations, the provisions of AR 100–15 are modified by instructions contained in this manual and any other instructions that may be issued by the theater commander.

■ 27. ACCURACY OF MAPS.—Maps are usually prepared with the objective of avoiding errors which are appreciable at the scale of the maps. The allowable discrepancy in contour elevations is not greater than one-half the contour interval. Greater discrepancies than these may be expected in special

maps prepared hurriedly or with meager control. Even an accurate map may soon become out of date because of changes in works of man. The map user should appraise the accuracy of his map and, normally, supplement it by recent aerial photographs.

SECTION VI

MAP REPRODUCTION

■ 28. FACILITIES AVAILABLE IN VARIOUS ECHELONS.—*a. Base lithographic plants.*—Such permanent lithographic reproduction establishments as may be authorized for the United States and oversea departments will be utilized in time of peace for map and other lithographic reproduction, and for research in reproduction methods and equipment suitable in the theater of operations. In time of emergency, these plants will be utilized for quantity reproduction of maps to the limit of their capacity.

b. Topographic battalion, GHQ.—The battalion is equipped with all of the normal simpler methods of map reproduction, and with presses permitting lithographic reproduction of map sheets approximately 24 by 34 inches in size; the battalion is prepared to take over and operate presses of larger sizes. Lithographic reproduction is performed under conditions approaching those of a permanent peacetime establishment.

c. Topographic battalion, army.—The equipment of the army topographic battalion is similar to that of a GHQ battalion. Maps are reproduced under conditions approaching those of a permanent establishment.

d. Topographic company, corps.—The corps topographic company is equipped to make field reproductions by various means. It is also equipped with rugged portable lithographic presses. Although lithographic work is normally performed in single color, multicolor reproduction is possible in cases where exactness in registration is not essential and time is available. The maximum size of sheet is less than in the army, with maximum size of impression normally about 17 by 19 inches.

e. Division engineers.—The unit engineers with cavalry and infantry divisions are equipped to reproduce simple sketches,

overprints, and overlays needed by division headquarters. In time of war, lithographic reproduction will not be possible. In time of peace, more extensive equipment may be attached to divisions for engineer training purposes or to compensate for training difficulties introduced by the absence of higher echelons. In the use of this attached equipment, care must be taken that no false conceptions as to the capabilities of unit engineers under war conditions are developed.

f. Headquarters of divisions, regiments, etc.—Most unit headquarters are equipped for reproduction of orders or sketches by the mimeograph or of overlays and tracings by hand methods.

■ 29. METHODS.—The various methods of map reproduction and description of the processes involved are given in *FM 5–245.

SECTION VII

MILITARY MAPS AND AERIAL PHOTOGRAPHS

■ 30. MAP CLASSIFICATION.—*a. General.*—The maps used in a theater of operations will consist of those available at the outbreak of hostilities and of those produced thereafter. The availability of maps will depend largely upon the location of the theater of operations and will vary from crude small scale planimetric maps to accurate well-prepared topographic maps suitable for enlargement. They will include various special purpose maps, such as road maps, railroad maps, aeronautical charts, etc. Large scale topographic maps suitable for tactical operations of small units may be expected only in isolated areas of limited size. Except in certain parts of Western Europe, topographic maps at scales as large as 1:20,000 will not be found. (See table in par. 37.)

b. Types of maps.—Maps for use in a theater of operations naturally fall into classification according to scale. The use of the various types of maps will depend upon the character of the theater of operations, type of operations, and nature of the opposition encountered.

(1) *Small scale maps.*—Maps of small scale varying from 1:1,000,000 to 1:7,000,000 are intended for the general plan-

*See Appendix.

ning and strategical studies of the commanders of larger units. Various general maps have been designed for these purposes.

(2) *Intermediate scale maps.*—Maps of intermediate scale, normally from 1:200,000 to 1:500,000, are intended for planning strategic operations, including the movement, concentration, and supply of troops. The Strategic Map of the United States, 1:500,000, has been designed for these purposes.

(3) *Medium scale maps.*—Maps of medium scale, normally from 1:50,000 to 1:125,000, are intended for strategical, tactical, and administrative studies by units ranging in size from the corps to the regiment. The United States Geological Survey map, scale 1:62,500, with wooded areas and road classifications added, has been found suitable for these purposes. For strategic areas, the War Department produces maps of this type. While not suitable for all purposes, the scale of 1:62,500 has been found to be the most advantageous for recording topographical detail for future use. For campaign, maps of this scale can be used for the purpose intended or may be enlarged or reduced according to the existing needs.

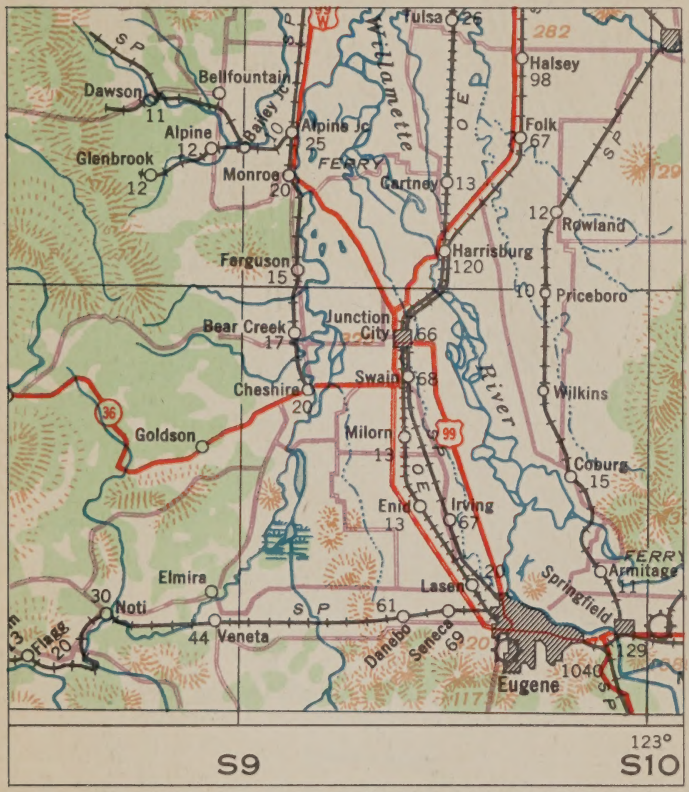
(4) *Large scale maps.*—Maps of large scale, normally not greater than 1:20,000, are intended for the technical and tactical battle needs of the Field Artillery and of the Infantry. It is unlikely that maps of this category will be found to cover extensive areas. The battle map scale 1:20,000 has been designed for this purpose.

c. Preparation of various types.—Suitable topographic maps prepared during peace will be utilized when available. When not existent at the outbreak of hostilities, maps of the various types must be promptly prepared. These maps will consist of those prepared initially by compiling information from existing source material and those produced by troops in the field.

(1) The small scale general map will be compiled from source material and reproduced as promptly as possible. This work is appropriate for base plants.

(2) The intermediate scale strategic map must be compiled from source material. This compilation will be done in base plants or by GHQ topographic battalions.

STRATEGIC MAP
WAR DEPARTMENT
CORPS OF ENGINEERS, U. S. ARMY



ENGINEER REPRODUCTION PLANT, THE ARMY WAR COLLEGE, WASHINGTON, D. C. 15038

Scale $\frac{1}{500000}$

10 0 10 Miles

PORTLAND

FIGURE 6

ENGINEER REPRODUCTION PLANT, THE ARMY WAR COLLEGE, WASHINGTON, D. C. 15038

Scale $\frac{1}{62500}$

1 0 1 2 Miles

1000 500 0 1000 2000 3000 4000 Yards

1500 0 3000 6000 9000 12000 Feet

1 0 1 2 Kilometers

ASTORIA, ORE.-WASH.

FIGURE 7.—MEDIUM SCALE MAP

(3) In an unmapped theater, data will rarely exist which will permit compilation of medium scale maps. The medium scale map, when not existent and when its use is essential, must be prepared by troops in the field. Topographic battalions can prepare maps at this scale. However, for maximum map production, the effort of the topographic battalions should be confined initially to maps of one scale. As the large scale map is normally of greater immediate importance to units in contact, preparation of the large scale map will normally have priority. Under these conditions and from the data thus secured, the medium scale map will be compiled later by the GHQ and army topographic battalions.

(4) The large scale maps, when available, will normally have the widest distribution in combat. For limited areas, data secured for maps of the medium scale will be suitable for enlargement in preparation of the large scale map. In general, large scale maps must be prepared by troops in the field for the area of immediate operation. Two general types of large scale maps, normally at a scale of 1:20,000, will be furnished, depending upon the situation but primarily upon the time available.

(*a*) The large scale map initially furnished in mobile situations, in development phases, and in all other situations where time is limited to a period of hours or days, will normally consist of a map substitute; it may either be in the form of direct reproductions of wide coverage photographs or mosaics, or in the form of the provisional map, with or without relief, prepared from such photographs. This hasty type of map will be required primarily by lower echelons, including the corps when operating as part of an army. In mobile situations, the holding attack of an army, which initially would required maps only to a limited depth, may frequently be provided only with map substitutes.

(*b*) The battle map will replace all map substitutes in the area of immediate operations as the situation becomes more stabilized. For description of the battle map, see paragraphs 6*a* and 10*b*. It may subsequently be used for the preparation of the medium scale map.

d. Aeronautical charts.—Sectional aeronautical charts, scale 1:500,000, and regional aeronautical charts, scale 1:1,000,000,

published by the United States Coast and Geodetic Survey, give complete coverage of the United States for air navigation. Other forms of aeronautical charts for specialized use are also available. The aeronautical chart consists of a map upon which information pertaining to air navigation has been added, and its primary use is for aerial navigation. Aeronautical charts covering many important areas of the earth's surface at various scales are readily obtainable. If not available in event of hostilities, they will be compiled at the earliest practicable opportunity.

e. Aerial photographs.—The aerial photograph read directly or stereoscopically is particularly suited for minor tactics, and for supplying detailed information of terrain in limited areas. Photographs will generally be of a scale of 1:20,000 or larger. Urgent needs for special tactical, technical, or intelligence purposes may be met by the production of contact prints within the airplane after day or night photography.

■ 31. MAPS AND THEIR RELATION TO COMBAT ARMS.—The type of map available to troops greatly influences their combined employment. The best procurable maps are essential to efficient use of the combined arms, and provisions should be made for obtaining them and for keeping them up to date by photography.

a. Infantry.—The utility of the photomap in infantry combat is evident. The advantage of stereoscopic study of areas selected for tank operations should not be overlooked.

b. Artillery.—The type of map available and the continuity of the supply of current photographs of the target area greatly influence the effectiveness and coordination of artillery fire. A large proportion of suitable targets can be identified only on the aerial photograph. Observation may be impossible and registration fire prohibited, yet the map should be sufficiently detailed and accurate to enable the artillery to locate its targets from the photographs with such precision that data may be computed and fire placed upon them.

c. Engineers.—The part played by engineers in procuring and reproducing the necessary maps and photomaps for the use of the troops is one of their most important missions.

d. Air Corps.—If troops lack adequate and detailed maps and photomaps, it is a mission of the Air Corps to procure the necessary photographs of the area of combat for use as maps and for use in map making.

e. Cavalry.—Aerial reconnaissance supplemented by aerial photographs is of extreme importance to Cavalry, particularly mechanized Cavalry. Except where time is available for its preparation, the use of the mosaic will be exceptional and primary recourse must be had to single aerial photographs. The greatest use of the photograph will be had in delineating objectives, assembly areas, critical points of terrain, critical points on routes, and enemy activity in rear areas, particularly during pursuit.

■ 32. PHOTOMAPS AND PROVISIONAL MAPS.—Dependence for topographic information, particularly in the earlier stages of campaign, may have to be placed on photomaps or provisional maps. (See par. 24.) In addition to furnishing information for those maps, the product of the aerial camera will always be of value in supplementing information on existing maps. The aerial photograph will provide the best obtainable means of securing the latest information of enemy terrain, and the larger scale photographs, particularly when examined stereoscopically, will offer detailed information of the terrain which can be secured by no other means.

■ 33. AERIAL PHOTOGRAPHIC INFORMATION IN RECONNAISSANCE.—Aerial and terrestrial reconnaissance will be more effective and the results obtained more accurate if aerial photographs are used to supplement the best obtainable maps, in planning reconnaissance and preparing reports thereon, and for locating targets which cannot be seen by observers. For inaccessible areas, stereoscopic examination of aerial photographs will frequently suffice.

■ 34. AERIAL PHOTOGRAPHIC INFORMATION IN OTHER COMBAT PHASES.—In addition to map use, aerial photography has particular application in combat. It permits not only the selection of cover for our own troops but reveals possible areas of occupancy by the enemy. It offers a means provided by no substitute for detailed study of critical points, such as

communication centers, bridges, entraining stations, railheads, bivouacs, etc., both for our own occupancy or for utilization by the enemy. It offers a valuable accessory for fire control. Because of the minuteness of detail, aerial photographs are of particular value in planning night operations, river crossings, and landing operations.

■ 35. STEREOSCOPIC EXAMINATION OF AERIAL PHOTOGRAPHS.—When the aerial photograph is examined by stereoscopic methods, additional detail is revealed. The accidents of relief, depth of cover, folds of ground, routes of approach, and other features of military importance are shown by the stereoscope with practically the same clarity as can be secured by personal reconnaissance. Stereoscopic examination of aerial photographs is of importance in intelligence work, for commanders of small combat units, and particularly for tank or mechanized operations. (See * FM 21–25, FM 21–35, and FM 30–21 for instruction on the use of the stereoscope and for information on technical and tactical interpretation of aerial photographs.)

■ 36. MAPS AND PHOTOMAPS FOR THEATER OF OPERATIONS.—The following table indicates the types, source, purpose, etc., of the maps and photomaps which might be made available in the theater of operations, according to circumstances.

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* See Appendix.

TYPES OF MAPS AND PHOTOMAPS FOR THEATER OF OPERATIONS

Kind of map	Scale	Originals and limited copies furnished by—	Reproduced in quantity by—	Method of reproduction	Used by—	Purpose	Probable time or conditions when available[2]
Battle map, uncontoured.	1:20,000.	GHQ and army topographic battalions.	GHQ and army topographic battalions.	Lithography in 1 or more colors.	All arms, supplemented by photographs.	General field uses. Horizontal control for unobserved fires by artillery.	For limited areas: 7 days or more after photography.
Battle map, contoured.	1:20,000.	GHQ and army topographic battalions.	GHQ and army topographic battalions.	Lithography in 1 or more colors.	All arms, supplemented by photographs.	Used by all arms. Horizontal and vertical control for unobserved fires by artillery. Suitable for tactical and technical uses.	For limited areas: 2 weeks or more after photography.
Composite photograph.	As taken, 1:20,000 to 1:60,000.	GHQ or army topographic battalions.	GHQ army, or corps topographic companies.	Transformed prints assembled by Air Corps; lithographed by engineers.	Topographic engineers for mapping. All arms as map.	Photogrammetry by topographic engineers. Copies of early availability for general field uses. Approximate horizontal control for limited unobserved fires by artillery.	24 to 48 hours after photography.
Mosaic, controlled.	As taken, enlarged or reduced.	Corps topographic companies. Civilian agencies.	Corps topographic companies.	Hand contact printing; rapid contact printer; lithography.	All arms and echelons.	Infantry as firing map. Horizontal control for unobserved fires by artillery.	24 to 72 hours after photography, depending on amount of control used.
Mosaic, uncontrolled.	As taken, enlarged or reduced.	Corps topographic companies. Civilian agencies.	Army topographic battalions. Corps topographic companies.	Hand contact printing; rapid contact printer; lithography; blueprints.	All arms and echelons.	General field uses.	24 to 28 hours after photography.
Strip mosaic.	As taken, enlarged or reduced.	Air Corps. Corps topographic companies. Civilian agencies.	Corps topographic companies.	Hand contact printing; rapid contact printer; lithography; blueprints.	All arms and echelons.	Infantry as firing map. Approximate horizontal control for limited unobserved fire by artillery. General field uses.	24 hours after photography.
Provisional map.	1:20,000 to 1:60,000.	Corps topographic companies.	Army topographic battalions. Corps topographic companies.	Lithographed tracings made from photographs in 1 color.	All arms as a map.	Map of early availability for field uses. Approximate horizontal control for limited unobserved fires by artillery.	Tracing of planimetric details 24 to 48 hours after photographs. With form lines added 48 to 72 hours. Roughly contoured in color 3 to 5 days.
Strategic map.	1:500,000.	Corps of Engineers.	GHQ and army topographic battalions.	Lithography in 1 or more colors.	High command, special staff, mechanized and motorized units.	Strategy and logistics.	Limited quantities on M-day. Reproductions: 24 hours.

TYPES OF MAPS AND PHOTOMAPS FOR THEATER OF OPERATIONS—Continued

Kind of map	Scale	Originals and limited copies furnished by—	Reproduced in quantity by—	Method of reproduction	Used by—	Purpose	Probable time or conditions when available [2]
Topographic map, contoured.	1:62,500.	Geological survey.[1] Corps of Engineers.[1]	Geological survey and GHQ and army topographic battalions.	Lithography in 1 or more colors.	All arms and echelons.	General field uses. Tactical and logistical studies by units from corps to regiment.	Limited quantities on M-day. Reproductions: 24 to 48 hours (very limited areas of U. S.).
Topographic map, contoured.	1:125,000	Geological Survey.[1] Corps of Engineers.[1]	Geological survey and GHQ and army topographic battalions.	Lithography in 1 or more colors.	All arms and echelons.	Substitute for 1:62,500 topographic map.	Limited quantities on M-day. Reproductions: 24 to 48 hours (limited areas of U. S.).
Topographic map, scale smaller than 1:125,000	1,125,000 or smaller.	Corps of Engineers. Other Government agencies.	GHQ and army topographic battalions.	Lithography in 1 or more colors.	High command, special staff, special troops. All arms and services.	Strategy and logistics.	Limited quantities on M-day. Reproductions: 24 hours or more.
Vertical aerial photographs	1:5,000 to 1:20,000	Air Corps. Civilian agencies.	Army topographic battalions. Corps topographic companies.	Hand contact printing; rapid contact printer; lithography.	All arms and echelons.	Target location. Detailed reconnaissance. Intelligence. Minor tactics. Stereo-pairs and triplets.	Limited numbers: 3 to 5 hours after photography. Quantities: 48 hours after photography.
Coast charts and harbor charts.	Miscellaneous	Coast and Geodetic Survey, U. S. Hydrographic Office, U. S. Lake Survey Office.[1]	Coast and Geodetic Survey and GHQ and army topographic battalions.	Lithography.	All arms and echelons.	Coast artillery in harbor defense. All arms in coastal frontier defense.	Limited quantities on M-day. Reproductions: 24 to 48 hours.
Miscellaneous maps.	Miscellaneous	Federal, State, railroad, and other civilian agencies.	Civilian agencies. GHQ, army, and corps topographic units.	Lithography in 1 or more colors.	All arms, supplemented by photographs.	Logistics, maintenance, and operation of communication.	Limited quantities on M-day. Reproductions: 24 hours or more.
Road maps	Miscellaneous	Civilian agencies.[1]	American Automobile Association, oil companies, etc.[1]	Lithography in 1 or more colors.	All arms and services.	Logistics. Concentration mechanized units. Maintenance and operation of communication.	Limited quantities on M-day. Reproductions: 24 to 48 hours.
Sectional and regional aeronautical charts.	1,500,000 to 1:1,000,000	Coast and Geodetic Survey, U. S. Hydrographic Office.[1] Corps of Engineers.[1]	Coast and Geodetic Survey, Corps of Engineers, U. S. Hydrographic Office.	Lithography.	Air Corps. Other arms.	Aerial navigation and as strategical map substitute.	Limited copies for U. S. on M-day. Reproductions: 24 to 48 hours.

[1] The data as to existing maps contained in this table concern primarily the continental United States. Appropriate modifications are necessary in order to conform to conditions in other theaters of operations.

[2] Time estimates are predicated upon adequately organized, equipped, and trained mapping (Air Corps, Engineer) and reproduction (engineer) troops. Under less favorable conditions more delay must be expected

■ 37. MAP SHRINKAGE.—*a.* Map paper expands or contracts under varying atmospheric conditions, and is caused primarily by change in relative humidity. Map paper is constructed with a woof and a warp, which causes unequal rates of change in the different directions. Under extreme variations of atmospheric conditions the change of map scale is material, as will be shown by the figures below of measurements made between selected points on a map of a scale of 1:20,000, reproduced on a good grade of map paper.

Direction of measurements	Before test with paper dry	With paper dry	Paper dried	Maximum change
North—South	18″—10,000 yd.	18.075″—10,042 yd.	17.929″— 9,960 yd.	0.146″— 82 yd.
East—West	15″— 8,333 yd.	15.334″— 8,518 yd.	15.002″— 8,334 yd.	0.332″—184 yd.
NE—SW	22″—22,222 yd.	22.256″—12,364 yd.	21.951″—12,195 yd.	0.305″—169 yd.

b. Changes as great as those indicated in *a* above will seldom be found under normal conditions. However, the changes that do occur are so great that all maps should have graphic scales printed at the bottoms and at the sides. When accurate measurements are desired and until map paper is designed which will decrease these errors in scale, the graphic scale nearest in the direction of the course or range to be measured, should be used in determining map distances. The boxwood or metal scale should not be used in determining accurate distances.

c. The failure of adjacent map sheets to join along contiguous edges is frequently due to the maps being printed under different atmospheric conditions and should not be taken as conclusive evidence of map inaccuracies. When assembling several map sheets, topographic details appearing on edges of maps can frequently be brought into agreement by dampening the maps and stretching them when necessary.

SECTION VIII

MAP SUPPLY AND DISTRIBUTION

■ 38. RESPONSIBILITY.—*a.* In addition to duties relative to map supply and distribution, as prescribed in AR 100–15, the Chief of Engineers will, where practicable, prepare for the initial supply of such maps as may be needed in an emergency, including those published by the War Department, other agencies of the Government, or private agencies. During operations, he may be called upon to utilize facilities available to him, for the purpose of reproducing maps for the troops in the theater of operations.

b. The chief engineer of the theater of operations is responsible for the procurement of maps required for the operations and, under direct supervision of the assistant chief of staff, G–2, for their supply and distribution in accordance with approved policy of the theater commander.

■ 39. MAP SUPPLY.—*a.* An adequate supply of the best and most appropriate type of maps that the situation permits is

essential to efficient military operations. In addition, arrangement must be made for an adequate supply of aerial photographs of the theater of operations for use as maps or to supplement maps.

b. The impetus for map supply should come from the higher echelons. However, supply of maps and aerial photographs cannot be considered automatic. Map supply requires continuous coordination and supervision both as to procurement and distribution. (See par. 45 for channels of supply and distribution.)

■ 40. MAP REQUISITION.—*a. In the zone of the interior.*—Maps of the United States, its possessions, or of occupied territory will be furnished by the Chief of Engineers upon requisition passing through the normal channels of command. He will supply such maps of the theater of operations as are procured or reproduced by him in accordance with paragraph 38*a*.

b. In the theater of operations.—Maps are class IV supplies. They will be furnished upon requisition in the same manner as other engineer class IV supplies. (See par. 45.)

■ 41. AERONAUTICAL CHARTS REQUIRED BY AIR CORPS.—In the zone of the interior, the Chief of the Air Corps will procure all aeronautical charts needed for air navigation therein. The Chief of Engineers is charged with the procurement, production, and distribution of all aeronautical charts and maps needed in the theater of operations.

■ 42. INITIAL ALLOWANCES OF MAPS.—The fundamental basis for the allowance of maps is the current and immediate prospective interest of the individual or organization concerned, in the area depicted by the particular map in question. Of the larger scale maps only those of the area of immediate importance will be furnished, and the allowances prescribed herein shall not be construed to permit general distribution throughout a command of all the large scale maps of the theater. The initial allowances of military maps will normally be as follows:

a. Small scale maps.—(1) *Regular.*—One copy per headquarters component shown in Tables of Organization of each organization considered down to and including the battalion or similar unit.

(2) *Exception.*—Organizations covered by special allowances.

b. Intermediate scale maps.—(1) *Regular.*—(*a*) One copy per commissioned officer of each headquarters shown in Tables of Organization down to and including the battalion or similar unit.

(*b*) One copy per organization assigned a Table of Organization down to and including the battalion or similar unit.

(*c*) One copy per section of division, brigade, regimental, and battalion staffs.

(2) *Exceptions.*—(*a*) For the Cavalry, the allowance will be increased by 50 percent.

(*b*) For the Air Corps, aeronautical charts will be issued in lieu of the intermediate scale map.

c. Aeronautical charts.—The allowance of aeronautical charts for the Air Corps is—

25 to GHQ Air Force.
100 to division headquarters (air section).
10 to each wing headquarters.
10 to each group headquarters.
4 to each squadron headquarters.
4 per airplane.

d. Medium scale and large scale maps.—(1) *Regular.*—(*a*) One copy per commissioned officer.

(*b*) Copies for each component shown in Tables of Organization of each organization considered, as follows:

3 copies per component regiment or larger unit.
2 copies per component battalion.
1 copy per component company.

(*c*) One copy per section of division, brigade, regimental, and battalion staffs.

(2) *Exceptions.*—(*a*) The Air Corps will be allowed 10 copies of the medium scale map per observation airplane. No

copies of the large scale map will normally be issued to the Air Corps.

(*b*) 100 to division staff.

NOTE.—Division headquarters (or, in the case of smaller expeditions acting independently, the headquarters thereof) will normally be allowed an additional quantity of each map equal to 50 percent of the initial distribution provided above, normally to be in custody of the division or detachment engineer, to be issued as required prior to the reproduction of maps in the field.

■ 43. INITIAL AND REPLACEMENT ALLOWANCES IN THEATER OF OPERATIONS.—The theater commander is authorized to change the initial allowances for maps as given above and to prescribe the initial and replacement allowances for maps and aerial photographs for his theater of operations.

■ 44. MAPS REQUIRED BY A TERRITORIAL COMMAND.—The engineer of a territorial command will keep copies, properly indexed, of all official topographic and geographic maps pertaining to the territory under the jurisdiction of his headquarters. Requirements for maps within the command will be submitted to the engineer, who will requisition, through engineer channels, such quantities of maps as are needed. Necessary issue of maps will be made to the command by its engineer under such instructions as may be issued by the commanding officer.

■ 45. MAP DISTRIBUTION IN THE FIELD.—The engineer of every unit larger than a brigade is charged with the distribution of military maps under the policies of the commander and supervision of the unit G–2, except such confidential or secret maps as may require special distribution. He will obtain maps not published by himself from the engineer of the next higher unit. The following table gives the channels for map supply and distribution:

MAP DISTRIBUTION

1	2	3	4
Organization or unit	Agency responsible for drawing and issuing maps	Agency from which maps are secured	Remarks
GHQ and GHQ troops.	Engineer-GHQ [2]	War Department GHQ topographic battalion [2] and base plants.[2]	G–2 will supply the headquarters.
Army	Army engineer [2]	Army topographic battalion [2] and engineer GHQ.[2]	G–2 will supply the headquarters.
Corps	Corps engineer [2]	Corps topographic company [2] and army engineer.[2]	G–2 will supply the headquarters.
Division	Division engineer[2]	Corps engineer [2]	G–2 will supply the headquarters.
Regiment	Regimental S–2	Division engineer [2]	
Battalion [1]	Battalion S–2	Regimental S–2	
Company [1]	Company commander.	Battalion S–2	

[1] Applies similarly to squadrons, troops, or batteries.
[2] These agencies only are authorized to maintain stocks of maps.

■ **46. Disposition of Maps When Troops Leave Area.**—Whenever a tactical organization is relieved from duty in a particular area, the commanding officer thereof is responsible that all maps and photomaps are collected and turned over to the commanding officer of the relieving unit or, if not replaced by troops, to the engineer of the territorial command, who will, within a reasonable time, cause all unserviceable copies to be destroyed under the personal supervision of an officer. Particular care will be taken to insure that no maps or map substitutes are abandoned.

SECTION IX

TROOP TRAINING IN USE OF VARIOUS MAPS

■ 47. USE OF WARTIME MAPS.—*a.* Troops will use in training the types of maps that will be furnished progressively in time of war in an unmapped theater of operations. For this purpose the list of maps given in paragraph 30 will serve as a guide; variations from the scales shown must be expected and accuracy may not be uniform.

b. Maps and map substitutes prepared by units of the Corps of Engineers and of the Air Corps of army posts, camps, and other training areas will conform to the types that will be furnished during combat in unmapped areas.

c. Echelons of all arms will include in their training programs the use of all such forms of maps and photomaps as will be used during combat. It is the duty of all who are responsible for training to acquaint the using arms with the type of maps which are likely to be available to the troops in war. While some maps prepared under wartime conditions are made at a scale of 1:20,000, the 1:20,000 contoured map, prepared under purely peacetime conditions, will not be habitually used in the field. This restriction on use of maps during training exercises will not apply in foreign possessions.

■ 48. TRAINING IN USE OF AERIAL PHOTOGRAPHS AND MAP SUBSTITUTES.—*a.* In many theaters of operations, up-to-date and appropriate topographical maps will not be available, and it will be necessary that commanders augment available maps by the use of aerial photographs and mosaics of local areas made in preparation for or during specific operations. In extreme cases no topographical maps will be available and troops must rely wholly on reproductions of aerial photographs and mosaics.

b. Special attention will be given to training in aerial photograph reading. Wherever practicable and when the allotted funds permit, aerial photographs and mosaics should be used in connection with field training. Where reproductions of

aerial photographs and mosaics are available, they should occasionally be substituted entirely for maps in field training. The Air Corps and engineer mapping echelons should be required to produce maps and map substitutes during field exercises.

c. Where possible, the photomaps used in training should be inexpensive lithographic reproductions, made locally in corps areas or departments, of mosaics or air photographs. In these reproductions, care will be taken to assure that the quality of the lithographs will be such that antagonism to the use of all aerial photographs will not develop. Where facilities are not available, application for the photomaps should be made as prescribed in AR 100–15.

■ 49. TRAINING IN STEREOSCOPIC VISION.—All officers and noncommissioned officers should be instructed in stereoscopic vision. Training will be conducted in all organizations both with and without stereoscopic equipment. Elaborate equipment is not essential for the training and when a sufficient number of stereoscopes is not available, simpler types should be improvised. FM *21–25, FM 21–35, and *TM 5–220 will be used as texts in presenting this training.

■ 50. TRAINING IN USE OF FOREIGN MAPS.—*a.* Facility in the use of maps may be acquired only by training with the various types which can be secured. Many nations depict topography by the use of hachures. If practicable, general and special service schools should include in their training use of the hachured map as well as maps of varied scale.

b. The following table shows the scales of military maps most frequently used by the various nations of the world.

*See Appendix.

SCALES OF MILITARY MAPS MOST FREQUENTLY ENCOUNTERED

Military maps	Purpose	United States	France	Italy	Germany	U. S. S. R.	Great Britain	Japan
1 : 8,000,000 to 1 : 1,000,000.	General	X	X	X	X	X	X	X
1 : 500,000	Logistical and strategical	X	X [1]	X				X
1 : 250,000	Logistical and strategical						X	
1 : 200,000	Logistical and strategical		X	X	X	X		X
1 : 100,000	Tactical and logistical			X	X		X	
1 : 80,000	Tactical and logistical		X					
1 : 75,000	Tactical				X			
1 : 62,500	Tactical	X						
1 : 50,000	Tactical		X	X		X	X	X
1 : 25,000	Tactical for small units			X	X	X	X	X
1 : 20,000	Tactical for small units	X	X					
1 : 10,000	Firing		X	X	X	X		X

[1] Type aviation.

■ 51. USE OF MAPS BY COMMANDERS AND STAFF.—Terrain exerts a profound effect upon the conduct of military operations. A proper conception and use of terrain may be the margin between victory and defeat. Commanders and staffs of all echelons must constantly study terrain and its effect on prospective maneuvers. For lower echelons, this study may be made on the ground, but for higher echelons it normally will be made from the map. The study of the map will furnish information chiefly on relief, drainage, cover, obstacles, and routes of communication. This map study may be sup-

plemented by other studies on natural resources, meteorological data, populations, etc. The results of the map study can readily be presented in the form of an estimate of the terrain.

■ 52. CARE OF MAPS.—Care in the use of maps is enjoined upon all concerned. In military operations the demand for maps always exceeds the supply, and consequently every care should be taken to avoid wastage. Folding of unmounted maps is detrimental to the maps and will be avoided when possible. Maps should be filed flat and not rolled. The use of map cases with celluloid rainproof covers in the field will avoid changes due to weather. When folding is necessary, fold like a bellows to a convenient size with the printed surface out. This enables the user to change from one area on the map to another with minimum effort and time and reduces tearing.

APPENDIX

LIST OF REFERENCES

1. General publications covering the coordination of military maps and mapping:

AR 100–15, Military Maps and Mapping.

FM 30–21, Military Intelligence, Role of Aerial Photography.

2. Publications of a general nature pertaining to maps and mapping:

FM 21–25, Elementary Map and Aerial Photograph Reading. (Now published as Ch. 5, BFM, Vol. I.)

FM 21–30, Conventional Signs.

FM 21–35, Sketching.

TM 5–220, Advanced Map and Aerial Photograph Reading. (Now published as TM 2180–5.)

3. Publications pertaining to the Corps of Engineers in performance of their mapping duties:

FM 5–5, EFM, Engineer Troops. (Now published as EFM, Vol. I.)

TM 5–230, Topographic Drafting. (Now published as TR 190–25.)

TM 5–236, Surveying Tables. (Now published as TR 1190–50.) (May be useful to other arms.)

TM 5–240, Aerial Photographic Mapping. (Now published as TR 190–27.)

TM 5–245, Map Reproduction in the Field. (Now published as TM 2180–37.)

TM 5–300, Symbols for Seacoast Defense Fire-Control Maps, Diagrams, and Structures. (Now published as TR 1050–5.)

4. Publications pertaining to Air Corps duties in reference to military maps and mapping:

FM 1–30, ACFM, Air Navigation.

FM 1–35, ACFM, Aerial Photography.

TM 1–220, Aerial Photography. (Now published as TM 2170–6.)

5. Coast Artillery publications relative to surveying:
   - FM 4–5, CAFM, Seacoast Artillery—Organization, Training and Tactics. (Now published as Pt. One, CAFM, Vol. I.)
   - FM 4–15, CAFM, Seacoast Artillery—Fire Control and Position Finding. (Now published as Pt. Two, CAFM, Vol. I.)
   - FM 4–105, CAFM, Antiaircraft Artillery—Organization, Training, and Tactics. (Now published as Pt. One, CAFM, Vol. II.)
   - FM 4–110, CAFM, Antiaircraft Artillery—Gunnery, Fire Control and Position Finding. (Now published as Pt. Two, CAFM, Vol. II.)
   - FM 4–155, CAFM, Reference Data. (Now published as Pt. Three, CAFM, Vol. II.)
   - TM 4–225, Coast Artillery Orientation. (Now published as TM 2160–25.)
6. Field Artillery publications relative to surveying:
   - FM 6–20, FAFM, Tactics and Technique.
   - FM 6–40, FAFM, Firing.
   - FM 6–120, FAFM, The Observation Battalion.
   - FM 6–130, FAFM, Reference Data.
   - TM 6–200, Field Artillery Survey.

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